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Policy Bias and Agriculture: Partial and General Equilibrium Measures

Romeo M. Bautista, Sherman Robinson, Finn Tarp, and Peter Wobst*

Abstract

The paper examines the impact of industrial protection, agricultural export taxes, and overvaluation of the exchange rate on the balance between the agricultural and nonagricultural sectors. Various agricultural terms-of-trade indices are constructed to measure the policy bias against agriculture in a computable general equilibrium (CGE) framework and compare the results with earlier partial equilibrium measures. Our results indicate that the partial equilibrium measures miss much of the action operating through indirect product and factor market linkages, while overstating the strength of the linkages between changes in the exchange rate and prices of traded goods on the agricultural terms of trade.

1. Introduction

Empirical studies on the effects of government price interventions in developing countries, especially those undertaken since the early 1980s, support the view that there was substantial policy bias against agriculture.¹ First, producer prices are often found to have been suppressed *directly* by sector-specific policies, commonly in the form of agricultural export taxation or the pricing policy of parastatal marketing organizations. Second, economywide policies, including trade and macroeconomic policies that influence the real exchange rate, are shown to have had significant *indirect* effects, invariably adverse, on agricultural incentives. In most cases, the indirect impact of economywide policies is found to be more important than the effect of direct government interventions.

In taking into account the additional effect on agricultural incentives arising from indirect government interventions, these studies have gone beyond the narrow, sectoral orientation of traditional agricultural policy analysis. However, in general, they have relied on analytical frameworks that are partial equilibrium. Economists have long recognized that the partial measures used in applied work are incomplete and that a general equilibrium framework is needed to capture all the interactions that determine the net relative impact of a mix of policies on the agricultural and non-agricultural sectors. “Policy bias” is inherently an economywide, general equilibrium concept. Nevertheless, to date there has been no systematic evaluation of the extent of agricultural bias of government interventions using a general equilibrium framework.

Another critical problem with partial equilibrium approaches is that they typically assume perfect substitutability between domestically produced and imported goods, as well as between domestic products for export and for internal use. Under these assumptions, we should never observe two-way trade (“cross-hauling”) at the commodity level. If a good is tradable, the “law of one price” holds and changes in world

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prices should be completely translated into changes in domestic prices; and the responsiveness of domestic prices to changes in world prices or in trade policies should not depend on the shares of trade in sectoral demand or supply.

All these implications of the law of one price are empirically suspect.² For example, two-way trade is observed in highly disaggregated sectoral data for virtually all countries (de Melo and Robinson, 1981). Within agriculture in developing countries, there are also significant shares of nontraded goods or goods with very low trade shares. In any case, price transmission elasticities vary widely across sectors. Evidence for major traded agricultural commodities indicates that price transmission elasticities are close to 1 for developed countries, although significantly lower for developing countries (Mundlak and Larson, 1992). Ardeni (1989), on the other hand, finds that changes in world prices or trade policy measures are generally only partially transmitted through to prices of domestic substitutes. In general, elasticities of substitution and transformation are much lower for industrial goods in developing countries, especially intermediates and capital goods.

By contrast, a widely used specification in multisector, trade-focused, computable general equilibrium (CGE) models is that imports are imperfect substitutes for domestically produced goods with the same sectoral classification. Similarly, in many models, exports are also differentiated from domestically produced goods sold on the domestic market. This formulation removes the extreme dichotomy between tradable and nontradable goods, allowing differing degrees of tradability corresponding to different values of the substitution and transformation elasticities (which are either infinite or zero in the partial equilibrium approach, depending on whether the good is traded or not). This specification gives some realistic autonomy to the domestic price system in the model and can account for cross-hauling.³

In this paper, we use a computable general equilibrium (CGE) model that incorporates the more realistic assumption of imperfect substitutability to provide a comprehensive framework to capture the various repercussions of policy interventions and measure their impact on agriculture.⁴ Assuming that the economic environment is characterized by trade policy distortions such as the ones in focus in Krueger et al. (1988), we will consider the differences between general equilibrium measures of the agricultural sector bias with the results of partial equilibrium analysis.⁵ Following this introduction, the partial equilibrium measures used in previous work are presented. Section 3 discusses how the bias against agriculture can be measured in a CGE model, and indicates why this frame of reference is preferable to the partial equilibrium approach. The results of a series of policy experiments designed to provide answers to the questions raised above are reported in section 4, and section 5 concludes.

2. Agricultural Bias: Partial Equilibrium, No Product Differentiation

Assuming perfect substitutability between domestically produced and traded goods, a change in the world price will—under competitive conditions—lead to the same change in the domestic market price of the traded good. However, government policies can drive wedges between foreign and domestic prices. Krueger et al. (1988; KSV hereafter) developed partial equilibrium measures of the impact of these policies on agricultural producer prices. These measures are used to assess whether the policy-induced incentive structure favors or discriminates against agricultural production; i.e., whether the sector is protected or not relative to nonagriculture. They distinguish between policies that have direct and indirect effects on agricultural incentives.

Policies with direct effects include agricultural sector-specific import and export taxes, price controls, and production taxes and subsidies, all of which affect the wedge between producer and border prices of agricultural products. Policies with indirect effects on agricultural incentives, on the other hand, include the exchange rate, which affects the economywide balance between traded and nontraded goods, and import tariffs on nonagricultural products. Contrary to the assumption used by KSV, we recognize below the latter's influence on the exchange rate.

Following KSV (but using different notation), let PX_{iag} be the domestic producer price of a specific tradable agricultural product iag , PX'_{iag} the border-price equivalent at the official exchange rate E_0 , and P_X^{AGN} the nonagricultural producer price index defined as the weighted average of nonagricultural producer prices. The relative producer prices of agricultural products *vis-à-vis* the nonagricultural aggregate price are given by $P_{iag} = PX_{iag}/P_X^{AGN}$ and $P'_{iag} = PX'_{iag}/P_X^{AGN}$.

The direct agricultural bias against products indexed by iag is defined as the proportionate deviation of relative prices from what they would have been without direct interventions:

$$DAB_{iag} = \frac{P_{iag}}{P'_{iag}} - 1 = \frac{PX_{iag}}{PX'_{iag}} - 1. \quad (1)$$

This measure captures the impact on producer incentives of commodity-specific policies, and it corresponds to the widely used "nominal protection rate" in the empirical trade literature.

Let PX_{iag}^* be the border price evaluated at the equilibrium exchange rate E^* , and define $(P_X^{AGN})^*$ as the nonagricultural price index where the tradable part is evaluated at E^* , defined as a situation with a sustainable trade balance and no trade restrictions. In this case, E^* differs from E_0 to the extent that the current account is set at an unsustainable level and trade interventions are in place. The relative price is given by $P_{iag}^* = PX_{iag}^*/(P_X^{AGN})^*$, where $(P_X^{AGN})^* = \alpha(P_{Xt}^{AGN})^* + (1 - \alpha)P_{Xnt}^{AGN}$, and Xt refers to tradable goods (whose price is evaluated at the equilibrium exchange rate, E^*) and Xnt refers to nontraded, nonagricultural goods.

The indirect agricultural bias against the sector indexed by iag is the proportionate deviation of PX'_{iag} from PX_{iag}^* :

$$IAB_{iag} = \frac{P'_{iag}}{P_{iag}^*} - 1 = \frac{E_0(P_X^{AGN})^*}{E^*P_X^{AGN}} - 1. \quad (2)$$

This measure is meant to capture the indirect effects on producer incentives of the exchange rate disequilibrium (E_0 differing from E^*) and of trade policy affecting P_X^{AGN} (e.g., industrial protection). The implicit assumption that $P_X^{AGN}/(P_X^{AGN})^*$ and E_0/E^* are independent shows that the partial equilibrium framework does not capture intersectoral price linkages and also assumes no repercussion through changes in the exchange rate induced by the price changes.⁶

The exchange rate affects the terms-of-trade (ToT) ratio depending on the shares of traded and nontraded goods within the agricultural and nonagricultural sectors. If all goods in the economy are tradable, then the exchange rate is irrelevant since, in that case, all domestic relative prices are set by world prices. The exchange rate is important precisely because there are nontraded goods. In the KSV studies, the agricultural products considered were tradable (i.e., with some observed exports or imports) and some nonagricultural goods were not tradable. In that environment, exchange rate changes affect tradable agriculture much more than partially nontraded

nonagriculture. Considering agriculture as a whole, it is important to consider non-traded agricultural goods in defining aggregate ToT indices.

The total agricultural bias against sector *iag* can be represented by the proportionate deviation of PX_{iag} from PX_{iag}^* :

$$TAB_{iag} = \frac{P_{iag}}{P_{iag}^*} - 1, \tag{3}$$

which captures the effects of both direct and indirect government interventions.

The three measures are related as follows:

$$TAB_{iag} = DAB_{iag} \left(\frac{P'_{iag}}{P_{iag}^*} \right) + IAB_{iag}. \tag{4}$$

The first term on the right-hand side of equation (4) is a modified measure of the direct agricultural bias, which is usually smaller (in absolute value) than the nominal protection rate since PX'_{iag} is typically less than PX_{iag}^* in developing countries.

In contrast with the partial equilibrium measures used in the World Bank studies, which are concerned with producer price incentives only, a general equilibrium approach will capture intersectoral resource shifts, product differentiation in production and demand, and the effect of induced price changes on the equilibrium exchange rate. The result is a richer specification of the price system and a more complete concept of agricultural bias.

3. Agricultural Bias: General Equilibrium and Product Differentiation

If domestically produced and imported goods (DC_i and M_i , respectively) are imperfect substitutes, the price of the domestic good, PDC_i , will no longer be equal to the domestic-currency price of the import substitute, PM_i , as in the partial equilibrium framework. Similarly, if there is imperfect substitutability between domestic products for export (E_i) and for internal use, their prices— PE_i and PDA_i , respectively—will not be identical. It follows that the domestic prices of exported and imported products are not determined by the law of one price.

Structure of the Applied CGE Approach

Following Armington (1969), we can introduce product differentiation by defining a composite good Q_i which is a CES (constant elasticity of substitution) function of the domestic product DC_i and the import substitute M_i . Likewise, a production good X_i can be defined as a CET (constant elasticity of transformation) function of the domestic product in sector *i* for internal use DA_i and for export E_i . Under the small-country assumption (i.e., the country's imports have an infinitely elastic world supply and its exports have an infinitely elastic world demand), world prices of imports, pwm_i , and of exports, PWE_i , are determined exogenously. The domestic prices of imported and exported products are given by

$$PM_i = pwm_i(1 + tm_i)EXR, \tag{5}$$

$$PE_i = PWE_i(1 - te_i)EXR, \tag{6}$$

respectively, where EXR is the exchange rate (in domestic currency per unit of foreign currency), and tm_i and te_i are the implicit tariff and export tax rates, respectively, that

take account of the legal tariffs and export taxes as well as any quantitative trade restrictions and direct price controls that affect the disparity between the domestic and border prices of traded goods.

From the underlying general equilibrium model used here, the relationships between relative prices and quantities are

$$\frac{M_i}{DC_i} = CES^* \left(\frac{PM_i}{PDC_i} \right), \quad (7)$$

$$\frac{E_i}{DA_i} = CET^* \left(\frac{PE_i}{PDA_i} \right). \quad (8)$$

We use the convention that CES and CET refer to “constant elasticity of substitution” and “constant elasticity of transformation” functions, while CES* and CET* refer to the corresponding first-order conditions for utility maximization and profit maximization.

Sectoral composite good prices are the weighted averages of the domestic prices of their component products:

$$PQ_i = \frac{PDC_i \cdot DC_i + PM_i \cdot M_i}{Q_i} = CES(PDC_i, PM_i), \quad (9)$$

$$PX_i = \frac{PDA_i \cdot DA_i + PE_i \cdot E_i}{X_i} = CET(PDA_i, PE_i), \quad (10)$$

where the CES and CET functions refer to cost functions relating the composite prices to their component prices. They reflect the first-order conditions described above.

Equations (5)–(10) are embedded in the structure of a computable general equilibrium model incorporating differentiated products. This model permits the determination of the direct effects of government interventions (captured in tm_i and te_i) on agricultural prices, and also their indirect effects through intersectoral linkages and induced changes in the exchange rate.⁷

To make the CGE agricultural bias results derived in this study as comparable as possible to the partial measures described above, we adapt the CGE model to provide a “clean” theoretical starting point for measuring policy bias and also use the framework for doing controlled experiments that isolate particular effects.

First, in the model, factor markets have been segmented with respect to aggregate agricultural and nonagricultural sectors. Labor and capital can move between sectors within agriculture and nonagriculture, but cannot move between agriculture and nonagriculture. In this model, the derived agricultural sector bias measures reflect only price changes and intrasectoral resource shifts. The partial equilibrium measures focus only on prices, and so indicate potential resource pulls if factors were free to move between agriculture and nonagriculture. In the CGE model, by restricting factor mobility between agriculture and nonagriculture, the resulting equilibrium prices, and measures of bias based on them, should be comparable to the partial equilibrium measures. In an “unrestricted” CGE model, allowing inter-aggregate-sector factor mobility, adjustment would include both price and quantity effects. In general, allowing quantity adjustment will reduce price adjustment, so the segmentation should lead to price effects which are upper bounds. Indeed, the most appropriate measure of bias would be to allow full factor mobility and measure changes in value-added across sectors with removal (or addition) of distorting policies.

Second, as the base for our experiments, we create a distortion-free benchmark solu-

tion of the model to provide the theoretically best reference point for the analysis. Given existing distortions reflected in the base data, analysis of policy experiments is made difficult because there are potential “second best” effects from imposition of new taxes. To achieve an undistorted economic environment, the model is solved after setting all production, sales, and trade taxes to zero. The lost revenue is made up by means of a nondistorting lump-sum income tax on households, yielding the base value of government revenue—a standard approach in public finance models. This undistorted base solution is the starting point against which we compare all our experiments.

Third, the general equilibrium model incorporates the indirect effect of changes in tariffs and export subsidies on the economy through their impact on the equilibrium exchange rate—an indirect effect ignored in the partial equilibrium approach. To isolate this effect, we run a variant of the tariff and export subsidy experiments in which we fix the exchange rate, and so “turn off” this mechanism. In order to fix the exchange rate, we have specified a different macro “closure” and assumed that the trade balance adjusts endogenously.

Fourth, in the KSV methodology, overvaluation of the exchange rate is a major source of policy bias against agriculture.⁸ In a general equilibrium context, *EXR* represents the equilibrium exchange rate that is jointly determined by the remaining variables of the model, especially the balance of trade. The equilibrium exchange rate corresponding to a situation with no trade distortion and a “sustainable” (perhaps zero) trade balance E^* can be calculated with the CGE model, which provides a unified framework incorporating all relative prices, including the real exchange rate. Unlike KSV, no separate model is required to estimate the equilibrium real exchange rate. To measure the effect of changes in the exchange rate only (i.e., with no changes in distorting sectoral taxes), we report on a set of additional experiments where we systematically reduce the trade balance to zero, and solve for the resulting equilibrium exchange rates, and all other prices and quantities. The results show the sensitivity of the various agricultural ToT measures with respect to depreciation arising from the elimination of the trade deficit.

Finally, since the focus of the analysis is on the production rather than the consumption side, the nontraded producer price index of goods sold on the domestic market has been chosen as the *numéraire* of the model. For this choice, the solution value of the exchange rate measures the relative price of traded goods to nontraded goods—the “real” exchange rate of trade theory.⁹ In public finance models, it is common to use the consumer price index as *numéraire*, which is convenient for welfare analysis. The choice is only a matter of convenience. The model is a neoclassical general equilibrium model and only determines relative prices.

The underlying domestic price transmission mechanism is presented in Figure 1. A major shortcoming of the partial equilibrium approach is the assumed complete transmission of world price changes to domestic prices. Figure 1 shows the price links in the CGE model. Domestic prices of exported and imported products are determined by world market prices plus any trade taxes (given the small-country assumption). However, domestic sectoral producer prices (PX) are CET cost functions of export prices (PE) and domestic prices (PD). Similarly, the composite good prices (PQ) are CES cost functions of import prices (PM) and domestic prices. The strength of price transmission effects depends both on elasticities (of substitution and transformation) and on trade shares. There are also links working through intermediate inputs, which include imported and domestic goods, and finally to factor prices. In this model, the policy bias against agriculture will depend on differences in policies, trade shares, and the degree of tradability between agricultural and nonagricultural sectors.

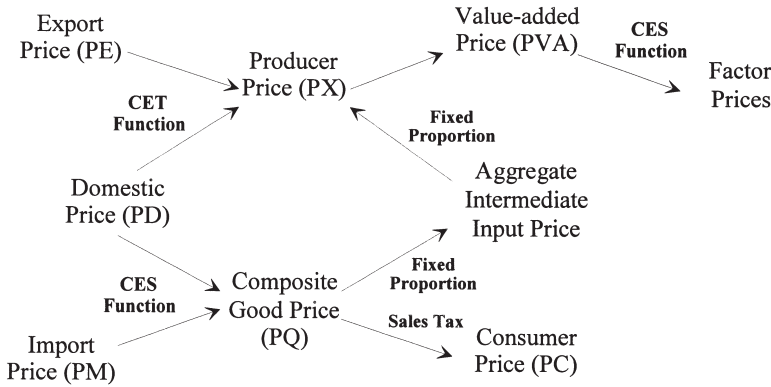


Figure 1. Domestic Price Transmission Mechanism

Measures and Policy Experiments in the CGE Framework

In the general equilibrium approach used here, the measure of agricultural bias is captured through various measures of the terms of trade between *aggregate* agriculture and *aggregate* nonagriculture. They are defined as the ratio of the relevant price indices. For example, the agricultural terms of trade with respect to gross output *X* in domestic producer prices can be represented as follows:

$$AG_X^{TOT} = \frac{\sum_{iag} PX_{iag} \cdot S_{iag}^x}{\sum_{iagn} PX_{iagn} \cdot S_{iagn}^x}, \tag{11}$$

where

$$S_{iag}^X = \frac{X_{iag}}{\sum_{iag} X_{iag}} \quad \text{and} \quad S_{iagn}^X = \frac{X_{iagn}}{\sum_{iagn} X_{iagn}}. \tag{12}$$

The share parameters are the gross output shares of individual subsectors in the agricultural and nonagricultural sectors. The sum of these shares within each aggregate sector equals one.

The aggregate sectoral producer price indices are defined as:

$$P_X^{AG} = \sum_{iag} PX_{iag} \cdot S_{iag}^X \quad \text{and} \quad P_X^{AGN} = \sum_{iagn} PX_{iagn} \cdot S_{iagn}^X. \tag{13}$$

The ToT measures within the CGE framework are constructed using the following prices and corresponding quantity weights:

- PM M domestic market price and quantity of imports
- PE E domestic market price and quantity of exports
- PQ Q composite good price and quantity
- PX X producer price and gross output
- PVA X value-added price and gross output.

Agricultural bias is measured by various agricultural ToT indices:

AG_M^{TOT}	agricultural TOT regarding PM and M
AG_E^{TOT}	agricultural TOT regarding PE and E.
AG_Q^{TOT}	agricultural TOT regarding PQ and Q
AG_X^{TOT}	agricultural TOT regarding PX and X
AG_{VA}^{TOT}	agricultural TOT regarding PVA and X.

A 28-sector—of which 13 are agricultural sectors—social accounting matrix (SAM) for Tanzania (base year 1992) provides the starting database for our policy simulations.¹⁰ Given that the data are preliminary and that we start from a distortion-free base solution, the model should be seen as reflecting a “stylized” version of a Tanzania-like economy. The model can be seen as characterizing a highly-agricultural, trade-dependent, developing country.

The structure of the economy is presented in Table 1, which provides sector-specific information on production, value-added, and trade shares; export and import ratios with respect to total production and absorption; and elasticities of substitution and transformation. The characteristics of this economic structure that significantly influence the results of the analysis can be summarized as follows:

- (a) The share of agriculture in total gross production is 42%, and 56% in value-added at market prices. This economy is dominated by agriculture.
- (b) The share of agriculture in total exports is only 26%, but the two most important agricultural export sectors (coffee and tea) have export-production ratios of around 80%. Most exports are nonagricultural, but there are some very export-dependent agricultural sectors.
- (c) There are virtually no agricultural imports. Most imports are intermediate and capital goods for which elasticities of substitution with domestic production is low. One sector, “fuel”, which includes petrochemicals, has high import and export ratios, indicating the existence of “passthrough” exports.

Four experiments are carried out to simulate the impact of introducing significant industrial protection and taxation of agricultural exports, with and without a fixed exchange rate.¹¹ These experiments are designed to simulate an “anti-trade” policy regime typical of many African countries in the past. We also do additional experiments to simulate the impact of devaluation under a structural adjustment program.

The first experiment simulates an “import substitution industrialization” (ISI) strategy by imposing a 25% import tariff ($tm(iagn) = 25\%$) on all nonagricultural imports. This sort of ISI strategy should hurt agriculture by: (a) raising the relative price of nonagricultural goods, which are import substitutes, compared with agriculture; (b) increasing the costs of production in agriculture (since nonagricultural commodities are used as intermediate inputs in agriculture); and (c) inducing an appreciation of the exchange rate which will hurt export-oriented agricultural sectors producing tradable goods.

The induced appreciation of the exchange rate represents an indirect effect which is considered to be independent in the partial equilibrium approach to measuring agricultural bias. To estimate the separate effect of this appreciation, in experiment 2 we also increase the nonagricultural tariff as in experiment 1, but fix the exchange rate, which serves to isolate the indirect exchange-rate effect. With the exchange rate fixed,

Table 1. Structure of the Model Economy

	Composition (%)				Ratios (%)		Elasticities	
	<i>X</i>	<i>VA</i>	<i>E</i>	<i>M</i>	<i>EX/X</i>	<i>IM/Q</i>	<i>SIGT</i>	<i>SIGC</i>
Cotton	0.5	0.3	—	—	—	—	—	—
Sisal	0.3	0.3	0.8	—	22.6	—	3.0	—
Tea	0.2	0.2	2.6	—	79.7	—	3.0	—
Coffee	0.8	0.8	9.7	—	82.9	—	2.0	—
Sugar	0.4	0.3	1.4	—	27.8	—	3.0	—
Tobacco	0.1	0.0	0.8	—	53.2	—	3.0	—
Cashew	0.1	0.1	0.7	—	46.5	—	3.0	—
Pyrethrum	0.1	0.1	0.5	—	44.1	—	3.0	—
Maize	7.5	10.7	1.5	—	1.5	—	3.0	—
Wheat	0.1	0.2	—	0.0	—	5.4	—	4.0
Paddy	1.9	2.8	—	—	—	—	—	—
Other Agriculture	21.8	29.3	5.4	0.1	1.8	0.1	3.0	1.1
Livestock	8.0	11.3	2.2	0.1	2.0	0.2	3.0	1.1
Mining	1.5	1.8	1.4	6.7	6.7	44.9	1.1	4.0
Food/beverages	5.4	3.2	4.9	7.1	6.5	21.2	1.1	4.0
Textiles	5.8	4.0	27.3	7.8	33.5	25.2	4.0	1.1
Fuel	0.1	0.1	0.8	4.8	62.4	95.7	1.1	0.8
Other chemicals	0.9	0.6	0.9	9.5	6.5	64.5	1.1	0.8
Nonmetal	1.0	0.4	1.5	3.5	10.7	40.1	1.1	0.8
Metal	2.2	1.4	2.9	31.9	9.5	73.2	1.1	0.8
T&M equipment	2.1	2.5	0.1	22.4	0.2	64.1	1.1	0.8
Electr./water	1.1	0.2	0.0	0.0	0.3	0.1	4.0	1.1
Construction	5.4	1.5	—	0.0	—	0.1	—	4.0
Commerce	16.6	12.3	21.0	0.3	9.0	0.3	4.0	1.1
Trans./comm.	5.9	8.3	4.8	0.4	5.8	1.3	4.0	1.1
Financial inst.	4.7	5.6	—	0.9	—	3.2	—	4.0
Other services	0.7	0.7	8.6	4.4	83.2	85.6	1.1	4.0
Public admin.	4.9	0.8	0.1	—	0.2	—	4.0	—
Total/avg. AG	41.8	56.4	25.7	0.2	3.4	0.1	—	—
Total/avg. non-AG	58.2	43.6	74.3	99.8	8.7	23.3	—	—

X, output; VA, value-added; E, exports; M, imports; Q, absorption; SIGT, elasticity of transformation; SIGC, elasticity of substitution.

Source: Distortion-free base solution of the CGE model for Tanzania using a preliminary 1990 SAM (Wobst, 1998).

the model is solved by endogenously adjusting the trade balance (as discussed above). This additional experiment allows comparison with the partial equilibrium measures which analyze the effects of taxation under the assumption of a fixed exchange rate.

The third and fourth experiments simulate the implementation of a 25% tax on all agricultural exports, again with a free and fixed exchange rate ($te(iag) = 25\%$ and EXR is either free or fixed). The impact of an export tax on agriculture in a partial equilibrium framework with a fixed exchange rate is referred to as the *direct* bias against agriculture. In the general equilibrium framework, the effect of an export tax can be divided into two components: (a) price changes due to trade price transmission effects,

given the CES-CET functional structure of the model; and (b) price changes due to the induced exchange-rate effect.

In the partial equilibrium literature, a major source of policy bias is the overvaluation of the exchange rate, even with no sectoral price distortions. To assess this effect, we perform a series of five experiments where we leave all sectoral taxes at zero but reduce the base value of the trade balance in 20% increments, reaching zero in the last experiment. In these experiments, the real exchange is solved endogenously, given the exogenous trade balance.¹² A trade balance of zero is often specified as defining the “appropriate” equilibrium value of the exchange rate in the partial equilibrium literature. Defining an equilibrium or “sustainable” trade balance is a macro issue, outside the scope of our static general equilibrium model. In the CGE model, there is a functional relationship between the exchange rate and the trade balance, and hence between the trade balance and measures of policy bias arising from changes in the equilibrium exchange rate. The five experiments indicate this relationship.

4. Results

Industrial Protection and Agricultural Export Taxes

Table 2 presents the impact on the various agricultural ToT measures of the imposition of the 25% nonagriculture import and agriculture export taxes, with and without a fixed exchange rate. The agricultural ToT measures and their underlying aggregate price indices are shown in the rows. The first two agricultural ToT measures with regard to traded goods (AG_M^{TOT} and AG_E^{TOT}) capture price-incentive effects which are close to

Table 2. Industrial Protection and Export Taxes in Agriculture

<i>Price indices</i> (base = 100)	<i>tm(iagn)</i> = 25%	<i>tm(iagn) and</i> <i>EXR fix</i>	<i>te(iag)</i> = 25%	<i>te(iag) and</i> <i>EXR fix</i>
AG_M^{TOT}	80.0	80.0	100.0	100.0
P_M^{AG}	94.7	100.0	105.3	100.0
P_M^{AGN}	118.3	125.0	105.3	100.0
AG_E^{TOT}	100.0	100.0	75.0	75.0
P_E^{AG}	94.7	100.0	78.9	75.0
P_E^{AGN}	94.7	100.0	105.3	100.0
AG_Q^{TOT}	94.4	90.2	93.9	98.8
P_Q^{AG}	98.9	96.9	96.8	99.3
P_Q^{AGN}	104.7	107.3	103.1	100.5
AG_X^{TOT}	98.3	94.9	93.7	98.0
P_X^{AG}	98.7	96.9	96.2	98.5
P_X^{AGN}	100.4	102.2	102.7	100.6
AG_{VA}^{TOT}	100.1	96.0	92.4	97.5
P_{VA}^{AG}	98.1	96.1	95.8	98.4
P_{VA}^{AGN}	98.0	100.1	103.7	100.9
EXR	0.95	1.00	1.05	1.00

the partial equilibrium measure. The last three measures (AG_Q^{TOT} , AG_X^{TOT} , and AG_{VA}^{TOT}) capture the transmission of price changes from traded goods through commodity, output, and value-added prices, reflecting general equilibrium linkages, the Armington specification of imperfect substitutability, and the operation of factor markets.

The last row shows that the exchange rate, which is fixed in experiments 2 and 4, appreciates by approximately 5% in experiment 1 and depreciates by 5% in experiment 3. The signs of the induced changes are predictable from theory—the magnitudes depend on model parameters and the structure of the economy.

The first agricultural ToT measure (AG_M^{TOT}) shows a 20% deterioration for experiment 2 due to the 25% increase of the nonagricultural price index P_M^{AGN} . World market prices in equation 5 are fixed in all experiments, given the small-country assumption, and the exchange rate is fixed as part of experiment 2. In the first two experiments, the 25% increase in import tariffs on nonagricultural production ($tm(iagn) = 25\%$) leads to a 20% decrease in the terms of trade ($1/1.25 = 80\%$). In experiment 2, with a fixed exchange rate, the tariff directly increases P_M^{AGN} while agricultural import prices remain unchanged. In experiment 1, the induced appreciation of the exchange rate changes all import prices, leaving relative prices, and hence the agricultural terms of trade, unchanged. Experiments 3 and 4, in which the domestic prices of agricultural exports are changed, have no influence on AG_M^{TOT} (as can be seen from equation (5)). With a fixed exchange rate, the export tax does not affect domestic import prices. Moreover, with a flexible exchange rate, as in experiment 1, P_M^{AG} and P_M^{AGN} change proportionately, leaving the terms of trade unaffected.

Tracing the effects of the four experiments on AG_E^{TOT} is equivalent to tracing the effects on AG_M^{TOT} as shown above. A 25% export tax on all agricultural sectors leads (see equation (6)) to a decrease in P_E^{AG} of 25% in experiment 4, where the exchange rate is fixed. Since P_E^{AGN} remains unchanged, AG_E^{TOT} decreases by 25%. With a flexible exchange rate (in experiment 3), the depreciation of the exchange rate following the relative price decrease of exports affects P_M^{AG} and P_M^{AGN} equally and therefore has no additional effect on AG_E^{TOT} . Experiments 1 and 2 have no influence on AG_E^{TOT} , as can be seen from equation (6). With a fixed exchange rate, the import tariff does not affect domestic export prices. With a flexible exchange rate, the induced appreciation in experiment 1 leads to the same relative changes of P_E^{AG} and P_E^{AGN} .

We now turn to the impact of the experiment series on AG_Q^{TOT} , AG_X^{TOT} , and AG_{VA}^{TOT} . The third measure of the agricultural terms of trade (AG_Q^{TOT}) is defined with respect to composite good prices and captures the Armington specification; i.e., the imperfect substitutability between imports and domestic products (equation (9)). The imposition of a 25% nonagricultural import tariff reduces AG_Q^{TOT} to 90.2% when the exchange rate is fixed. The composite good price index of nonagricultural commodities (P_Q^{AGN}), which is affected by domestic import prices (PM) as well as domestic supply prices (PDC), increases by only 7.3% instead of the 25% increase of P_M^{AGN} . For a “semitradable” good, both the import share and the substitution elasticity affect how changes in import prices are transmitted through to the price of domestic substitutes, and hence to the price of the composite good.

The agricultural price index drops to 96.9%. When the exchange rate is free, these effects are dampened and AG_Q^{TOT} drops to only 94.4%. The effect of not allowing the exchange rate feedback on AG_Q^{TOT} amounts to 4.2% points. Allowing exchange rate flexibility means that agriculture gets hurt less.

The 25% export tax on agricultural commodities affects the composite good price index of agriculture by only 0.7% owing to the limited magnitude of agricultural exports compared with domestic supply—most of agriculture is not traded. When

exchange rate feedback is allowed, *EXR* depreciates and the agricultural composite good price index drops while nonagriculture gains. The net result is that the export tax affects AG_Q^{TOT} relatively little when the exchange rate is fixed, but substantially more—and negatively—with a flexible exchange rate.

The fourth agricultural ToT measure (AG_X^{TOT}) is defined with respect to producer prices (*PX*), reflecting the imperfect transformation between domestic produce and exports in the CET function. The 25% import tariff in experiments 1 and 2 lowers P_X^{AG} in a similar way as P_Q^{AG} . Moreover, allowing for exchange rate flexibility results in an appreciation of the exchange rate and improves P_X^{AG} compared with the fixed exchange rate scenario. This result is a reflection of the very large share of nontraded agricultural products in total agriculture, which implies that aggregate agriculture is favored when the exchange rate appreciates. In addition, the price index of nonagricultural producer prices is higher under a fixed exchange rate.

In sum, AG_X^{TOT} is 98.3% under a flexible exchange rate and 94.9% under a fixed exchange rate. In case of the 25% export tax on agricultural products in experiments 3 and 4, the agricultural terms of trade are affected more under a flexible exchange rate than under a fixed exchange rate, while the direct impact of the export tax appears relatively limited. The depreciation following the imposition of the export tax in experiment 3 has a negative influence on the agricultural terms of trade, AG_X^{TOT} . This result again is linked to the high share of nontraded agriculture, which is hurt in relative terms by a depreciation. In the partial equilibrium literature, most agricultural commodities are treated as perfectly substitutable tradable goods for which eliminating an overvaluation of the exchange rate is beneficial.

Changes in the terms of trade in value-added prices, AG_{VA}^{TOT} , provide the most appropriate bias measure because they indicate relative incentives to “pull” productive factors between sectors. A nonagricultural tariff combined with a flexible exchange rate slightly improves the terms of trade of agriculture, whereas agriculture is hurt in relative terms under a fixed exchange rate. As noted above, agriculture is relatively nontraded, and therefore benefits from an appreciation of the exchange rate. Similarly, in the export tax experiment, exchange rate flexibility implies that AG_{VA}^{TOT} drops compared with the situation with fixed exchange rate.

Impacts of an Overvaluation of the Exchange Rate

The results of the experiment series in which we gradually reduce the trade balance to zero are reported in Figures 2, 3, and 4. Figure 2 shows that the trade balance is eliminated in five consecutive steps, resulting in exchange rate depreciations starting at almost 4% at the beginning and declining to about 1% at the last step. Elimination of the trade deficit leads to a depreciation of 10%. The corresponding adjustments in real imports and exports are shown in Figure 3. Imports move very little while exports increase by around 130%—the improvement of the balance of payments is mainly a consequence of export performance. The import-dependent nature of the economy, with high trade shares and low substitution elasticities for intermediates and capital goods, makes it difficult to reduce imports. They even increase a little in spite of the depreciation, which reflects the import-intensive nature of exports. This result (typical of many developing countries) underlines the need to maintain imports at an adequate level if export promotion is to succeed.

Finally, Figure 4 demonstrates that although the last three agricultural terms-of-trade indices fall as the exchange rate depreciates, the changes are small—under 5%. The first two indices, AG_M^{TOT} and AG_E^{TOT} , do not change since changes in the exchange rate

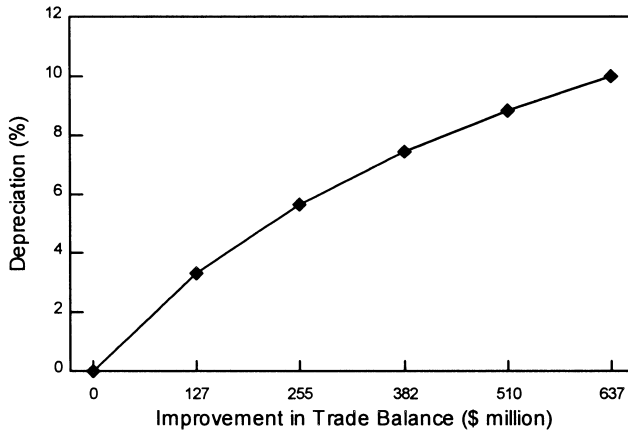


Figure 2. Exchange Rate Depreciation

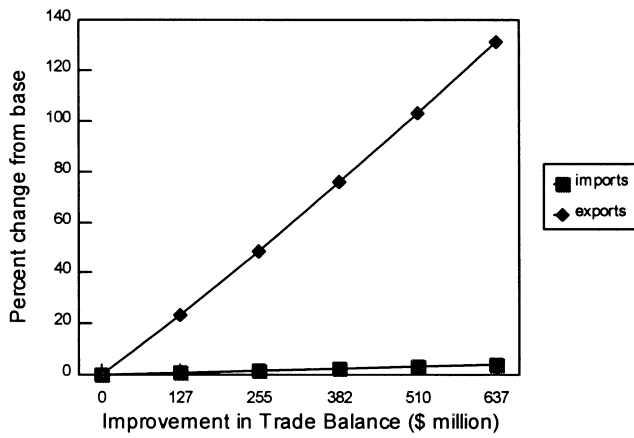


Figure 3. Real Trade and the Trade Balance

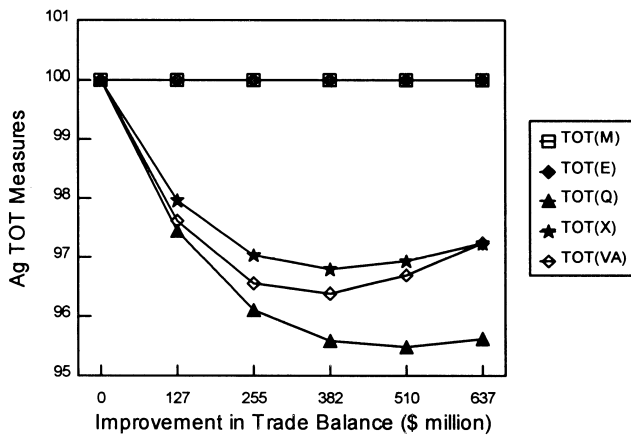
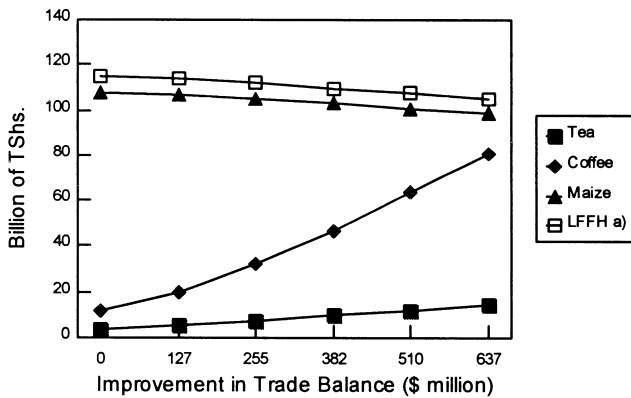


Figure 4. Agricultural Terms of Trade and the Trade Balance



a) LFFH = Lifestock, Forestry, Fishing, and Hunting

Figure 5. *Real Output for Some Agricultural Sectors*

effect agriculture and nonagriculture symmetrically. The other three agricultural ToT measures (AG_Q^{TOT} , AG_X^{TOT} , and AG_{VA}^{TOT}) decrease in the beginning owing to the induced depreciation of the exchange rate. However, the effect tapers off in the middle of the experiment series, and the measures improve a little at the end. The turnaround is due to the fact that agricultural exports increase with depreciation and, by the last two experiments in the series, grow to be a significant share of agricultural output. With depreciation, traded agriculture becomes more important (see Figure 5).

5. Conclusion

This paper has analyzed the extent of the policy bias against agriculture in a general equilibrium framework. Various measures of the agricultural terms of trade were constructed to assess the impact of industrial protection, agricultural export taxes, and overvaluation of the exchange rate on the balance between agriculture and nonagriculture. The general equilibrium measures have been compared with earlier work measuring policy bias in a partial equilibrium framework.

Our results indicate that trade policies have a significant but much lower negative impact on relative prices in agriculture than would be indicated by partial equilibrium measures. The general equilibrium framework captures indirect effects of trade policies that work through induced changes in the equilibrium exchange rate—an effect that is not captured in partial equilibrium analysis. We use the model to compute the empirical importance of this indirect effect, which is potentially significant. The imposition of a nonagricultural tariff with a fixed exchange rate leads to a much stronger deterioration of the ToT measures compared with a flexible exchange rate scenario, since the appreciation of the exchange rate actually benefits agriculture. The imposition of an export tax on all agricultural sectors with a fixed exchange rate leads to a much lower deterioration compared with a flexible exchange rate scenario, since the export-tax-induced depreciation of the exchange rate hurts the relatively nontraded aggregate agriculture in the case of a flexible exchange rate.

A separate series of experiments was carried out to assess the impact of overvaluation of the exchange rate—characteristic of many developing countries. In earlier

work, in a partial equilibrium framework, comparative work in a number of countries identified exchange rate overvaluation as the largest source of policy bias. In a general equilibrium framework, incorporating nontraded goods and imperfect substitutability between domestic and foreign goods, these results are seriously qualified. In our archetype model of Tanzania, agriculture has a large share of nontraded goods and traded nonagriculture goods have relatively low substitution elasticities. These characteristics reflect many developing countries. In this environment, we find a much smaller impact on agriculture of depreciating the exchange rate than is indicated by partial equilibrium measures. Our results are contrary to the “conventional wisdom” that a depreciation benefits agriculture. General equilibrium effects are indeed important.

This paper deals only with trade policies and their impact on aggregate agriculture. It is straightforward to expand the analysis to include sector-specific domestic tax and subsidy policies and their impacts on particular agricultural sectors. The CGE model is an appropriate analytical framework for such analysis.

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Notes

1. The findings of a World Bank comparative study during 1987–90 involving 18 countries are reported in Krueger (1992) and Schiff and Valdes (1992). Eight country studies done at the International Food Policy Research Institute (IFPRI) from 1981 to 1990 are contained in Bautista and Valdes (1993), together with regional surveys of the literature in Africa, Asia, and Latin America.
2. For the extended discussion on empirical testing of the law of one price and further references to earlier works, see Ceglowski (1994).
3. For a description of this CGE model specification, see Devarajan et al. (1997) and de Melo and Robinson (1989).
4. For a recent survey on general equilibrium analysis applied to agriculture, see Hertel (1997).
5. A related measure of government support to agriculture, the Producer Subsidy Equivalent (PSE), was developed during the Uruguay Round GATT negotiations and includes both trade and nontrade policies. It is also a partial equilibrium measure which treats trade basically the same way as the KSV approach (Josling and Tangermann, 1989).
6. In some of the IFPRI country studies referred to above, trade restrictions (including import tariffs and export taxes) are systematically examined as a major source of real exchange rate distortion; see, for example, Bautista (1987) for an empirical investigation of the Philippine case.
7. The complete specification of the model is given in Annex II in Bautista et al. (1998) and available under <<http://www.cgiar.org/ifpri>> or on request from the authors.
8. In fact, in most of their country studies, overvaluation was the greatest source of policy bias against agriculture.
9. See Devarajan et al. (1993) for a discussion of the real exchange rate in this class of CGE models.
10. The SAM is based on preliminary and incomplete data for Tanzania. A major work program is underway to improve the database. See Wobst (1998) for a description of an updated 1992 SAM. Note that the reported economic structure is for the distortion-free base solution of the model. The SAM was developed as part of a research project which is developing comparative SAM data for a number of African countries, including: Botswana, Madagascar, Malawi, Mozambique, South Africa, Tanzania, Zambia, and Zimbabwe.
11. Other government policies such as sales taxes or fixed producer prices could also be investigated within the CGE framework. However, in the present analysis, we focus on trade-policy-induced distortions.
12. We could also have fixed (and varied) the exchange rate and "closed" the model by solving for the corresponding equilibrium trade balances endogenously. The qualitative results would be the same—we trace out the functional relationship between the real exchange rate and the balance of trade.